







Variation of normal condyle shape based on gender in panoramic radiographs

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ABSTRACT

Objectives: To find out information about variations in the normal shape of the condyles based on gender using panoramic radiographic observations and to find out the frequency data for variations in the normal shape of the condyles.

Materials and Methods: This is a descriptive observational research using 122 panoramic radiographs as secondary data. The panoramic image consisted of 61 male samples and 61 female samples. The condyles were observed by describing the condyle shapes on the right and left sides. Observation of the shape of the condyle was carried

out by three observers. Then, the data were tested for reliability by using the Intraclass Correlation Coefficient to equalize the perceptions of the three observers.

Results: The reliability test using ICC obtained a score > 0.9 which means very good reliability. The most commonly found condyles shape is round and there are differences in shape between the right and left condyles in both males and females.

Conclusion: The most common variation of the normal shape of the condyle found in both males and females is round on the right and left sides.

Keywords: Gender, condyle shapes, panoramic radiographs

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INTRODUCTION

The temporomandibular joint (TMJ) is a joint that lies between the glenoid fossa and the mandibular condyle on the cranium base. This joint serves to maintain occlusion and stabilize the stomatognathic system. The TMJ consists of mandibular and temporal components consisting of the condyles, glenoid fossa, articular eminence, and articular disc which can maintain remodeling even after growth has ceased.^{1,2} The TMJ has a morphology that varies between individuals and may differ in shape in an individual.³ Various factors such as functional variations, occlusal loads, and pathological processes can play a role in the process of changing the morphology of the TMJ.⁴

The main areas of facial growth are indicated by mandibular growth which has an upward and backward direction of growth. The condyle is an important part of the TMJ which acts as a primary center of mandibular growth. The morphology of the TMJ needs to be understood because it is an important guidance in evaluating normal TMJ growth and development. The condyle shape varies greatly between individuals and is dependent on developmental variations along with the condyle remodeling process which contributes to trauma, malocclusion, and other pathological abnormalities. The study of condyle morphology can assist in the

diagnosis of temporomandibular joint disorders. In addition, condyle morphology may also help developments in forensic odontology in the future, because the TMJ exhibits high sexual dimorphism.⁵⁻⁷

A study in 1980 on the morphology of the condyles associated with malocclusion in children stated that the condyles in males are larger than in females. Tadej *et al.* also stated the same thing, that males had larger condyles in anteroposterior dimensions than females. This exhibits sexual dimorphism. However, the condyle is more vulnerable to growth on its mediolateral than the anteroposterior dimension. Morphological changes of the condyle exhibit a great sexual dimorphism which may help in the process of gender identification.⁷⁻⁹ Hormonal influences also contribute to condyle alterations. Sexual hormones play an important role in skeletal growth. In males, androgen hormones will mediate periosteal growth. High levels of androgen hormones cause males to have thicker cortical bone and greater muscle mass than females. Meanwhile, in females, the estrogen hormone has an important role in bone maintenance.¹⁰ However, the level of a hormone must be optimal hence not causing changes in the body. Structural changes in the TMJ can occur when

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the estrogen level in the body decreases. These changes include condyle erosion, decreased subchondral bone volume, increased TMJ cartilage thickness, and other degenerative changes.¹¹

Panoramic radiography is one of the extraoral imaging techniques which can present the condyles. This technique has often been used and can be a diagnostic tool because it helps diagnose jaw conditions in dental practice.¹² It has a broad scope area that provides an overview of the condyle, coronoid process, ramus, body, angle, teeth, and surrounding tissues. In addition, panoramic radiographs can also present abnormalities that occur in a jaw, such as fractures, trauma and, TMD. This technique has several advantages which are why it is preferred over other intraoral and other extraoral radiography techniques. These include low radiation dose, easy and rapid radiographic technique, and are also useful for patients with trismus who are intolerant of intraoral radiography well. In addition, it is also useful for visualization when educating patients and presenting cases.^{13,14}

Research of condyles shape is necessary to do. The TMJ appearance can make it difficult for the dentist to interpret and make a diagnosis. This is because the image on the TMJ can present bone abnormalities, position and if there is an abnormality arises. Therefore, interpreting the TMJ requires an understanding of the morphology of the observed condyles to distinguish the observed condyles belonging to the normal variation group or pathological abnormalities.¹⁵

Based on the description above, the authors are encouraged to research variations in the normal shape of the condyles based on gender using panoramic radiographs observations. Research relating to the normal shape of the condyles based on gender is still lacking to be found. Therefore, the author wanted to conduct research on variations in the normal shape of the condyles based on gender using panoramic radiographs observations.

This study aimed to find out information about variations in the normal shape of the condyles based on gender using panoramic radiographic observations. Through the information obtained, it

can be seen the frequency data for variations in the normal shape of the condyle. Variations in the shape and size of the condyles can assist in temporomandibular joint disorders diagnosis and assist in the process of gender determination.

MATERIALS AND METHODS

This research is a descriptive observational study that used secondary data from panoramic radiographs of males and females aged 20-40 years at UPF Radiology Dental Hospital (RSKGM-P) Universitas Airlangga in 2019-2021 which has been qualified the sample criteria. The inclusion criteria in this study were panoramic radiographs of males and females aged 20-40 years, panoramic radiographs that qualified the quality evaluation criteria, and the shape of the condyles with normal variations. Meanwhile, the exclusion criteria in this study were panoramic radiographs showing the loss of posterior first and second molars in both the maxilla and mandible and panoramic radiographs of individuals who had experienced condyle fractures. The sample in this study was taken using the purposive sampling technique to obtain samples that qualify these criteria.

The variables to be researched in this study were variations in the normal shape of the right and left condyles based on gender using panoramic radiographs observations. According to Arayapisit *et al.*, (2020) and Singh *et al.*, (2020), a normal condyle shape does not experience erosion of the bone cortex, or there is a slight erosion which is still considered normal. These two investigators grouped the condyles into four shapes: (a) Angled, with an acute angle on the posterior surface of the condyle; (b) Flat, the condyle surface from anterior to posterior is flat and smooth; (c) pointed, angled at the midpoint on the posterior surface of the condyle; and (d) Round, the anterior, posterior, and superior surfaces of the condyle are convex and rounded.

This research was conducted at Radiology Clinic, Dental Hospital (RSKGM-P) Universitas Airlangga

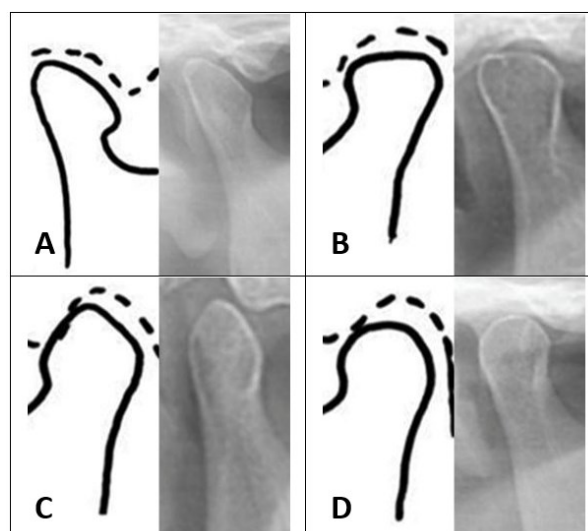


Figure 1. Classification of the shape of the condyle (a) angled; (B) flat; (C) pointed; (D) round

from August – to October 2021. All procedures conducted were in accordance with the ethical standards and were approved by the Health Research Ethical Clearance Commission Faculty of Dental Medicine Universitas Airlangga (No.429/HRECC.FODM/VII/2021). This research was observed the condyle shapes of panoramic radiographs that qualify the sample criteria. The observers consisted of 1 researcher and 2 supervisors who observed the condyles visually without any tools. The results of condyles observations will then be presented in the form of tables and graphs with simple statistical calculations such as mode. Then, the data were processed using IBM SPSS version 23 (IBM Corporation, USA) with a reliability test. The reliability test uses the intraclass correlation coefficient (ICC) to equalize perceptions between observers and maintain the validity and consistency of research data measurements.

RESULTS

This study observed the shape of the condyles in males and females on both sides of one jaw, using 122 panoramic radiographs that qualify the sample criteria. The sample consisted of 61 male subjects and 61 female subjects from UPF Radiology RSKGM-P Universitas Airlangga in 2019 – 2021 with a total of 244 condyles.

Based on the observations that have been done, the distribution of normal variations of condyle shape based on gender the most commonly found is round with a total of 130 samples. Round found as many as 68 subjects in males (55.7%) and 62 in females (50.8%). The second most common shape found in males was angled as many as 26 subjects (21.3%) and pointed and in females as many as 38 subjects (31.2%). Furthermore, the pointed shape was found in 25 subjects (20%) and the angled shape was found in females as many as 20 subjects (16.4%). Flat is the condyle shape with the least distribution found with a total of 5 subjects. The distribution in male is 3 subjects (2.5%) and female 2 subjects (1.6%). This distribution is shown in Table 1.

In this study, the results obtained were then tested for reliability. Reliability is a value that indicates a measuring consistency of an instrument. This reliability test is useful for showing the consistency of measurement results if a measurement is carried out more than once

using the same measuring instrument. A measuring instrument or data will be considered to be reliable if it still produces the same value even though it is measured many times¹⁶. From the measurements that have been carried out, the ICC value is more than 0.9, which means that the data reliability is excellent.

The distribution of condyle shape based on gender is shown in Table 1 with the result of intraclass correlation in Table 2. The most common distribution of condyle shapes in the sample was round as many as 130 subjects (53%), followed by pointed as many as 63 subjects (26%), angled 46 subjects (18.9%), and flat 5 subjects (2.1%). In the male sample, the round shape was found on the left side of the condyle as many as 35 subjects (28.7%) and 33 subjects (27%) on the right condyles. Furthermore, angled shapes on the right and left condyles of males were found in 13 subjects (10.7%). The third most common variation found was pointed, on the right side of the male condyles 13 subjects (10.7%) and the right side 12 subjects (9.8%). The last shape is flat, on the right side of the male condyles as many as 2 subjects (1.6%) and the left side only 1 subject (0.8%). Meanwhile, in females, the round shape of the left condyle was found in 33 subjects (27%) and on the right side as many as 29 subjects (23.8%). The next shape, which is pointed on the left condyle of females, was found in 20 subjects (23.8%) and the right side as many as 18 subjects (14.8%). The third shape is angled with 12 subjects (9.8%) on the female right condyle and 8 subjects (6.6%) on the female left condyle. The flat shape is rarely found, in the right condyles of females there are only 2 subjects found (1.6%) and on the left side, there is no flat shape found. The ICC value obtained is > 0.9, which means the data reliability is excellent.

The condyle can have different shapes in one jaw in the same individual. Based on observations and as shown in Table 4, there were 44 subjects (72.1%) male condyles with no different shape and 17 subjects (27.9%) with differences. In females, the number of the same condyles was found 41 subjects (67.2%), and differed condyles were more dominant than males, as many as 20 subjects (32.8%).

DISCUSSION

The results in this study indicate that the normal shape of condyles has variability. Following

Table 1. Distribution of normal condyle shape based on gender

Gender	Condyle shape				Total (%)
	Angled Total (%)	Flat Total (%)	Pointed Total (%)	Round Total (%)	
Male	26 (21.3%)	3 (2.5%)	25 (20.5%)	68 (55.7%)	122 (100%)
Female	20 (16.4%)	2 (1.6%)	38 (31.2%)	62 (50.8%)	122 (100%)
Total	46 (18.9%)	5 (2.1%)	63 (26%)	130 (53%)	244 (100%)

Table 2. Results of Intraclass Correlation Coefficient right and left condyles

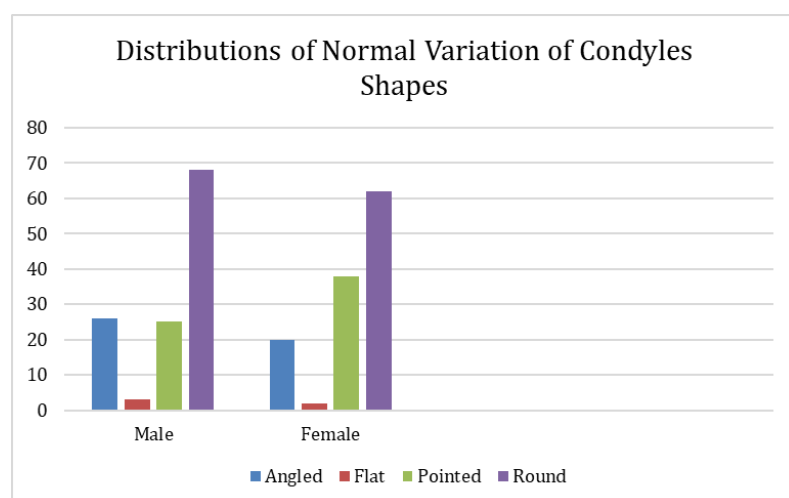
Gender	Condyle Side	Intraclass Correlation Coefficient
Male	Right	0.953
	Left	0.953
Female	Right	0.917
	Left	0.910

Table 3. Distribution of normal variations of condyles shape based on gender

Shape	Region	Male Total (%)	Female Total (%)
Angled	Right	13 (10, 7%)	12 (9.8%)
	Left	13 (10.7%)	8 (6.6%)
Flat	Right	2 (1.6%)	2 (1.6%)
	Left	1 (0.8%)	0 (0%)
Pointed	Right	13 (10.7%)	18 (14.8%)
	Left	12 (9.8%)	20 (16.4%)
Round	Right	33 (27%)	29 (23.8%)
	Left	35 (28.7%)	33 (27%)
Total		122 (100%)	122 (100%)

Table 4. Right and left condyle sides

Condyles shape	Male Total (%)	Female Total (%)
Same	44 (72.1%)	41 (67.2%)
Different	17 (27.9%)	20 (32.8%)
Total	61 (100%)	61 (100%)

**Figure 2.** Distribution of variations in the normal shape of the condyles

the research of Singh *et al.* (2020) which stated that the most common shape found was round. However, this shape is more dominant in males than females. This statement is in line with the research of Arayapisit *et al.* (2020) and Singh *et al.* (2020). The round shape is common, especially in

younger individuals. As time goes by, variations in the shape of the condyles have varied, including pointed, angled, and flat.^{15,17}

The second most commonly found shape is pointed. Previously it has been described that the round is more dominant in males. However, the

pointed is more commonly found in females. This is in line research of Arayapisit *et al.* (2020) and Singh *et al.* (2020). Arayapisit *et al.* (2020) stated that the pointed shape is more often seen on the lateral aspect of the condyle. The prevalence of the pointed shape which is more commonly found in females than males may aid the process of gender identification. The pointed shape is not only found in the TMJ with normal conditions but is also found in individuals with clicking which indicates the initial clinical symptom of TMD. The pointed shape can still be found in individuals with early TMD symptoms because clicking is still associated with morphology alterations and condyle position.¹⁸ The third most commonly found shape is angled. This shape is more dominant in males than females. This is following the research of Arayapisit *et al.* (2020). The angled shape has an asymmetrical sharp angle on the posterior surface of the condyle. Meanwhile, the pointed shape has a sharp symmetrical angle at the midpoint of the superior condyle. A study that evaluated condyle shapes in the dry human mandibles did not find an angled shape. The only shapes found were round, pointed, and flat.¹⁷

The shape which is rarely found is flat. In this study, flat shapes were more commonly found in males than females. This is in line with the research of Singh *et al.* (2020) and Arayapisit *et al.* (2020). On the left side of the condyle in females, there is no flat shape found, which is in line with the study of Singh *et al.* (2020). The flat shape in asymptomatic individuals generally arises as a suspicious symptom of pathology. Differences in condyle morphology can be associated with differences in distribution, direction, and magnitude of the stress received by the condyle. The condyle articular cartilage will undergo remodeling as an adaptive response to excessive biomechanical stress which leads to a change in the height and width of the condyle. Remodeling is the process of changing bone from old bone to new bone to reduce biomechanical stress. Each individual will experience a different adaptation process which causes variations in the shape and volume of the condyles that differ between individuals.^{3,19,20}

Song *et al.*, in their research, stated that in one individual, a difference can be found between the right and left side condyles.³ It was proven in this study that there were several subjects, both male and female, who had different condyles in one jaw. In this study, the prevalence of differences in the right side and left side of the condyles was more found in females. This is because females tend to have one-sided chewing habits. This can cause an imbalance in the development of the jaw which results in the condyles in asymptomatic individuals showing a different shape.²¹

Several researchers have different opinions regarding the causes of the differences in shape in the two regions. According to Arayapisit *et al.* (2020), this difference can occur due to anatomical variations and individual positions when panoramic photos are taken. Improper individual positioning, as well as photo distortion that causes the mandible to appear smaller or larger, can decrease the

validity of panoramic photographs when diagnosing TMJ.¹⁷ A good individual position when the panoramic photo procedure is carried out is the body is upright and the head is immobilized, and the teeth are located in the *focal trough*. Individual heads should not be positioned too forward, too backward, or asymmetrically.²²

The difference in the intensity of the occlusal load on the right and left sides of the condyle also causes differences in the two sides of the condyle. Individuals with lower intensity occlusal loads experience less pressure on the condyles during mastication. Meanwhile, individuals with high intensity of occlusal loads will also experience great pressure on the condyles during the masticatory process. Individuals with high occlusal load intensity tend to have larger and more rounded condyles. Differences were also shown in the volume of the left and right condyles in males and females. In males, the volume of the condyles is greater than that in females. The right condyle also has a larger volume than the left condyle.^{23,24} The difference between the two sides of the condyles is called condyle asymmetry.

Condyle asymmetry is a common condition that does not indicate a disorder but is a risk factor for temporomandibular disorders (TMD). The prevalence of condyle asymmetry in individuals with TMD symptoms varies quite a lot and approximately half of individuals experience TMD pain. Individuals with TMD generally have greater condyle asymmetry than individuals without TMD signs and symptoms. Condyle asymmetry is more common in patients who have a habit of chewing on one side only. Previous research has shown that individuals with one-sided chewing habits have more TMD symptoms than individuals with two-sided chewing habits. This results in an imbalance of masticatory loads that will affect the development of the jaw. The side that is passively used for chewing becomes less developed and causes the masticatory muscles to become asymmetrical because the side muscles that are active in chewing are thicker and stronger. This behavior can be caused by habit, the presence of painful teeth when chewing, and caries occurrence.^{25,26}

The bad habit of chewing on one side is more common in females, so it affects TMD symptoms, which are more common in females. A comfort will arise due to the habit of chewing on one side if pain occurs on the other side when chewing the food so that the individual will unconsciously chew on one side. This causes pain. In addition, the onset of pain is caused by an increase in the hormone cortisol in the saliva as a sign of an endocrine stress response. The level of stress and anxiety in females is higher than in males. This stress and anxiety will be expressed by clenching the upper and lower jaws tightly which causes excessive pressure on the facial muscles.^{27,28}

Based on the results of the above description, it can be said that the results of this study are following previous research, namely, the shape that is most commonly found is round and the shape

that is found the least is flat. As a suggestion for future research to find out variations in the normal shape of the condyles by gender, more samples and other radiographic techniques such as CBCT should be used to investigate variations in the typical form of the condyles based on gender. Furthermore, research on variations in the form of the condyles that include abnormal circumstances with gender variables, as well as in-depth study on variations in the shape of the condyles that take into account the superior and mediolateral portions of the condylus, is required. This study has limitations, including the small number of studies that address condyle differences, particularly those that address the gender variable. In addition, direct observation of the condyles without tools such as software can lead the shape of the condyles to be biased, resulting in differences of opinion between observers due to subjectivity, allowing each observer to have different opinions.

CONCLUSION

According to this study, the variations in the normal shape of the condyles based on gender were more commonly observed in males, with round, angled, pointed, and flat-shaped, as in order from the most common to the least. Meanwhile, the female samples were round, pointed, angled, and flat-shaped.

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FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This study has received ethical approval approved by the Health Research Ethical Clearance Commission Faculty of Dental Medicine Universitas Airlangga (No.429/HRECC.FODM/VII/2021). All procedures conducted were in accordance with the ethical standards.

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